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US ARMY INTELLIGENCE AND SECURITY COMMAND
FOREIGN SCIENCE AND TECHNOLOGY CENTER

TECHNOLOGY ALERT:

CHINESE MILITARY OPERATIONS RESEARCH (U)

March 1994

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TECHNOLOGY ALERT: CHINESE MILITARY OPERATIONS RESEARCH (U)

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PREFACE (U)

(U)

(U) Military science, including military operations research (MOR) and systems engineering, was embraced by the Chinese in the early 1980s. Since that time, Chinese developments in the area and their efforts to develop simulations have followed those of the West. These efforts have played, and continue to play, an important role in China's modernization efforts, and they have permeated all aspects of defense planning and building in China. This technology alert provides an introduction to the development of MOR in China; identifies key Chinese research institutes and 'think tanks' involved with MOR; describes MOR-related products with emphasis on tactical engagement simulations and training simulators; identifies the effects of technology transfer on Chinese MOR efforts; discusses the quality and success of Chinese efforts in MOR; and forecasts the future of MOR in China relative to China's modernization efforts, technology developments, and limitations.

(U) Simulation systems can include a variety of systems ranging from a mathematical model to a computer-based system to a physical mockup of the original system. For the purposes of this study, the terms simulation and simulator refer to systems that, based on our research, appear to incorporate the use of a computer(s) to emulate the function(s) of a system or the processes involved in the interaction of systems and humans in events ranging from combat operations to negotiation processes.

(U)

(U) Because of the magnitude of operations-research-based work in China's military and civilian arenas, this document has focused on efforts directly related to the military. However, because of the close association between Chinese military and civilian programs and the transfer of technology from one to another, some examples of key efforts in operations research and simulation are addressed.

(U) This document is intended to aid US research-and-development personnel in evaluating the threat and designing systems to counter it. Army requirements addressed in this product include AMC-92-K1-S-003 and AMC-93-A1-S-003.

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KEY JUDGMENTS (U)

(U) The key judgments derived from this study of Chinese military operations research (MOR) are as follows:

- (U) During the 1980s, MOR became an integral part of China's program for defense modernization.

- (U) Chinese work in nonlinear systems--particularly dissipative structures, synergetics (or complexity), and catastrophe theory--for MOR applications is probably near or at the level of Western research.

- (U) Chinese tactical engagement simulations are modular in design, often building on previous work and models. Chinese simulation research is closely following Western research efforts in the areas of combined-arms operations, real-time operations, audio-visual aids, and the use of expert systems.

- (U) China's training simulator program is marked by uncontrolled development, duplication, lack of coordination, and standardization.

- (U) MOR methods have been employed in forecasting China's military needs and defense strategies in the year 2000 and beyond. Examples include a study to determine the size of the People's Liberation Army in the year 2000 and a model addressing arms proliferation and negotiation.

- (U) China is building numerous centers and laboratories for developing simulators and conducting simulations. Many of these centers are world-class facilities, whose officers are aggressively seeking foreign investment and aid.

- (U) The United States has been a major supplier of MOR technology to China, followed by the former Soviet Union.

- (U) China's current simulators are assessed to be 5 to 10 years behind world standards. The lack of computing power will be the major obstacle for China to become a world leader in MOR. If restrictions on the export of computers to China are lifted, China can be expected to rapidly become a world leader. With the restrictions remaining in place, China can be expected to continue to follow the state-of-the-art in MOR but remain several years behind in actual developments and applications.

- (U) China's commitment to training simulators and simulation systems in the military and civilian sectors, to reducing military costs, and to modernizing its military will foster future developments in Chinese training simulators and simulation systems. These systems will be key indicators of future Chinese weapon systems, tactics, and defense strategies.

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1. Background (U)

a. (U) China's history in military operations research (MOR) dates back at least to the 5th century B. C. when the philosopher Sun Wu observed:

> Now the general who wins a battle makes many calculations in his temple ere the battle is fought. The general who loses a battle makes but few calculations beforehand.

Despite this legacy in MOR, organized efforts at studying and employing operations research (OR) within China did not occur until 1956 when China's first OR group was organized under the guidance of Qian Xuesen, a US-trained scientist.

b. (U) Substantial developments did not occur until after the Cultural Revolution and the initiation of China's plan for four modernizations in the late 1970s. The objectives of this plan were to double China's gross national product by the year 2000 and quadruple production in four areas: agriculture, industry, science and technology, and defense. These objectives are representative of China's shift from an emphasis on war preparation to economic construction and force modernization. Coincident with this shift were reductions in defense spending. These factors all resulted in the realization by Chinese military leaders and planners of the importance of OR methods in determining future weapon needs and acquisition strategies and avoiding duplication and incompatibility of weapon systems. A 1979 speech titled "Military System Engineering" by H. S. Tsien to high-ranking People's Liberation Army (PLA) officers addressed many of the advantages of OR methods in military planning. Tsien stated:

> Tactical simulation techniques provide an 'operational laboratory' in essence, in which simulated operational environment is made use of to experiment on tactics and plans, to examine their weaknesses, to predict their effect, to assess weapon systems operational efficiency, and to inspire new operational concepts. Tactical simulation techniques lead the systems engineering methodologies of modeling, simulations, and optimization into military decision making.

c. (U) Figure 1 shows significant MOR-related events within China during the 1980s. A 5-year plan for development and production of simulated training equipment for the PLA was drafted in 1981 as a result of a new strategic policy adopted by the Central Military Commission (CMC) and a paper by Zhang Zhen, currently vice-chairman of the CMC, calling for training reforms and emphasizing the use of simulators and audio-visual equipment for training. In 1986, production of electronic training equipment replaced capital construction as a priority goal, and the 863 High Technology Research and Development Plan (863 Plan), covering seven technological areas and including information technology and automation, was established.

d. (U) Also in 1986, former Defense Minister Zhang Aiping delivered a speech noting that military science would play a pioneering role in China's military growth. This speech, the 863 Plan, and the prioritization of military training led to the formation of China's first Five-Year Plan (FYP) on military science research. This plan, with military modernization and defense strategy objectives, was incorporated into the 7th FYP (1986-1990). As a result, a number of tactical engagement simulations (TES) and system simulation models were developed during this time.

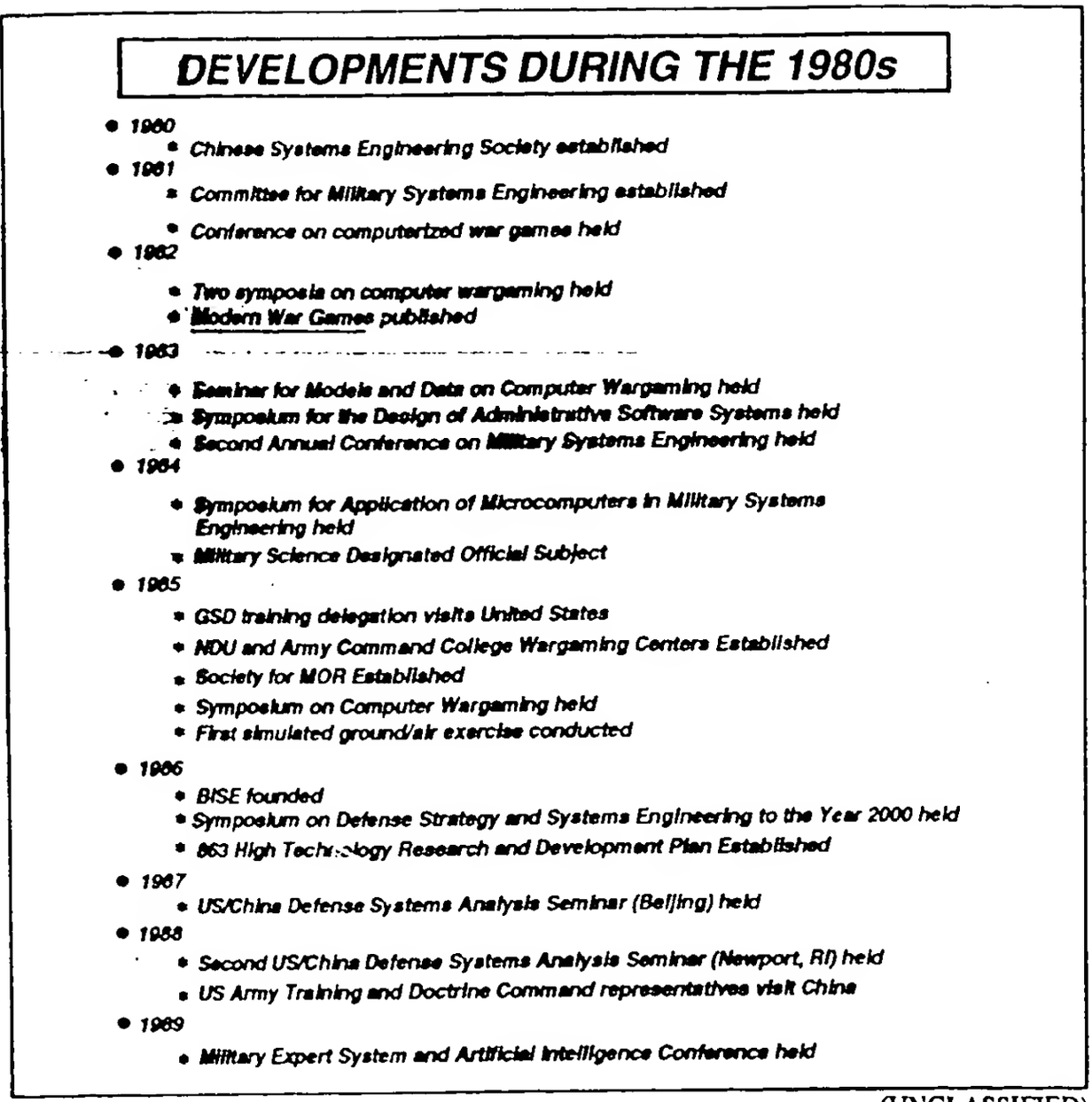

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Figure 1. (U) MOR-Related Events During the 1980s.

e. (U) Also for the first time during the 7th FYP, China organized more than 100 specialists and professors in the scientific and technological fields into groups to assist in formulating major science-and-technology-related policies and decisions. These groups discussed, analyzed, and evaluated all the major problems related to scientific and technological plans including military simulation and computer technology for the 7th FYP. They also provided direction for future development, recommended key and intermediate targets, and set priorities for research projects. The members of these groups, who came from more than 50 scientific research institutions, colleges, and universities, also established contacts with other experts in related scientific and technological fields forming a national technical consultation specialist network with over 1000 members.

f. (U) Chinese military science researchers were quick to adopt advanced scientific means and methods employed in MOR during the 1980s. These methods contributed to quantification of research work, automated information processing, simulated testing and training, scientific forecasting, and decision making. Despite concerns over quantitative-vs.-qualitative analysis, high-level commanders accepted and began to use software science to solve complex military problems, conduct research, and determine national defense policies. Chinese objectives for MOR and system analysis include the following:

- Demonstrate combat capabilities of weapons; conduct weapon evaluations; and create simulation models to demonstrate the operational effectiveness of antitank weapons, air-to-air and air-to-ground combat, and air-defense (AD) warfare.
- In tactics, study the allocation of fire, the introduction of submarines to the fleet, etc.
- Devise modeling and methodology for wargaming; improve techniques used for electronic-warfare simulation, attrition, microcomputers, etc.
- Conduct strategic studies in energy-based theories, national defense spending in the year 2000, etc.

2. Principal MOR Institutes, Organizations, and Facilities (U)

a. General (U).

(1) (U) The PLA began to establish MOR and systems engineering societies, organizations, and institutes to address OR issues, support the development of models and simulations, and establish contacts with the West in the subject area in the 1980s. Figure 2 is an organizational chart identifying some of the leading MOR institutes within the PLA and their relationship with the service branches.

(2) (U) The National Defense Science, Technology and Industry Commission (COSTIND) is directly subordinate to the CMC and coordinates all Chinese OR activities within the defense industries and military research-and-development (R&D) institutes. [redacted]

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b. Beijing Institute of Systems Engineering (BISE) (U).

(1) (U) Founded in March 1986, the BISE serves as the primary coordinator of OR activities for COSTIND. BISE is devoted primarily to the study of weapon-development strategies, science and technology and military software, and perhaps production analysis. The institute is divided into at least two divisions: software engineering and systems engineering. The professional staff was handpicked from various institutes and universities throughout China and represents the youngest and brightest of China's software and system engineers.

(2) [redacted]

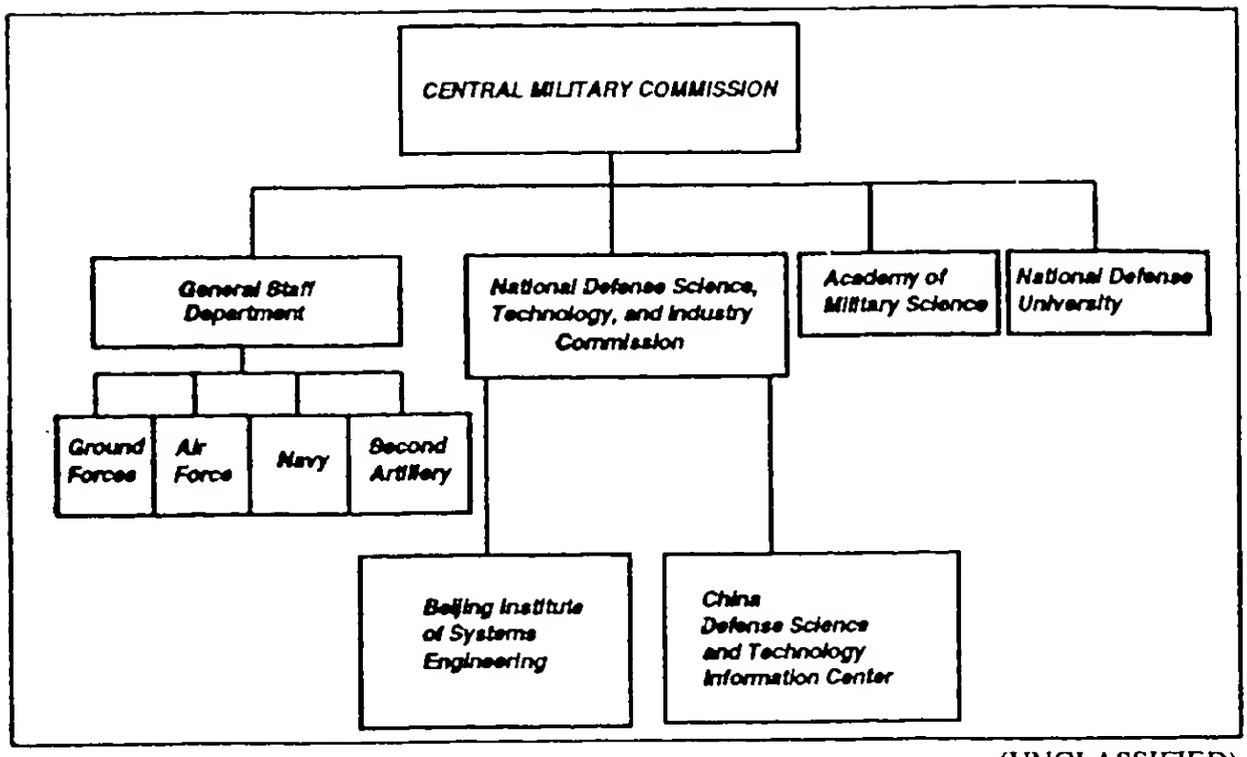

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Figure 2. (U) Organizational Chart of MOR-related Institutes and Organizations in China.

[redacted]

c. **AMS/MOR and Analysis Institute (MORAI) (U).**

(1) (U) (C) AMS has been one of the leading elements within China trying to modernize the military and ease the transition from the Maoist legacy of guerrilla warfare to current military concerns (i.e., local warfare, border incidents, etc.). AMS also assists the CMC and General Staff Department (GSD) with high-level direction in army building.

(2) (S) [redacted]

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(3) (U) AMS is currently organizing a large number of research personnel in a renewed effort to conduct intensive studies of modern scientific and technical knowledge. The academy is importing and applying new research methods as well as improving the quality of its research personnel and products. New facilities for MOR and for military command automation research are also being constructed. There are numerous complicated problems confronting the PLA as a result of the changes in the world's strategic patterns and rapid scientific and technical developments.

AMS helps by serving as a "think tank" to improve defense strategies, army building, and predictive research on important issues of future warfare. To accomplish this, the academy is applying methods such as cybernetics, systematology, information science, mathematics, and automation in its research in simulated operations, command automation, man-machine interface, and military data banks. Over 1000 strategic, campaign, and tactical research models, simulation systems, and special models have already been established by AMS to assist in its research work.

(4) (U) AMS comprises three institutes: MORAI, the Political Work Research Institute, and the Mao Zedong Military Thought Research Institute. MORAI originated as a five-man group studying MOR and systems analysis at AMS during the 1970s. By 1980 the group had expanded to become the Combat OR and Analysis Department, the first OR office in the PLA. In June 1986, they became MORAI.

(5) (S)

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

(6) (U) MORAI also serves as host agency for the Committee of Military Systems Engineering. The committee was established in 1981 to promote research and is composed of more than 60 member organizations, including AMS, military academies, the "General Departments," and service and defense ministry research institutes. The committee holds an annual conference, convenes seminars, and publishes books and magazines on the application of MOR, software, wargaming, and the prediction of future strategy.

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d. **National Defense University (NDU) (U).**

(1) (C-REL CAUKAS) The NDU was established in 1985 as a military research center and the PLA's premier training facility for senior military officers. Researchers at the NDU have developed their own software and models to simulate combat, combat support functions, AD, naval, and general defense. [redacted]

(2) (C-REL CAUKAS) [redacted]

e. **MOR Societies and Associations (U).**

(1) (U) A growing number of societies within China are also involved with MOR, systems engineering, and simulation. Among these are the Chinese Systems Engineering Society, which was established in 1980. The society, apparently composed of representatives from civilian and military R&D, scientific, academic, and industrial circles, [redacted]

(2) [redacted]

(3) (U) The Chinese Military Science and Technology Association was formed in 1991 as the first academic group of the entire military forces. The association serves as a military and academic research organization of the general public to exchange and spread the results of military and scientific research activities, to develop international exchange in military and academic areas, to encourage academic ties with foreign research organizations and researchers, and to organize activities to evaluate and recognize the results of academic research. Although no specific influence by this association on China's MOR efforts can be identified, the participation of key personalities from AMS, BISE, and other influential MOR-related groups indicates the potential influence of this association on Chinese research efforts.

(4) (U) Numerous military colleges have also introduced OR, control theory, systems engineering, information theory and electronic computer science into their curricula since 1984, when military science was designated an official subject. Most are also involved in mathematical modeling and the development of computer models and simulators.

f. **Simulation Centers and Laboratories (U).**

(1) (U) Since the early 1980s, China has established many simulation centers and laboratories in the military, industrial, and academic sectors to support modeling and simulation efforts. The creation of simulation centers and laboratories in these different sectors indicates China's commitment to and reliance on simulation for modernization.

(2) (U) The Sanjie Training Center, considered to be an experimental project based on training centers built by foreign armed forces, is the first combined tactical training center of the PLA. The center was activated in the Nanjing military region (MR) in April 1986, with completion scheduled for 1990. The center's main tasks include test and assessment of unit combined tactics, research into new techniques of combined tactical training, and evaluation of new equipment and training aids. The center trains regimental and higher echelon units in combined-arms training and includes a computerized tactical simulation system. The center can accommodate 3 to 4 complete divisions on maneuvers and 8 to 10 division headquarters practicing simulated confrontation exercises annually.

(3) (U) The Armored Forces Engineering College is equipped with the PLA's first modern armored force simulator training center. The center is equipped with various types of terrain mockups and a few tank simulators, a firing simulator room, and a communications simulator room.

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(4) (S)

[redacted]

(5) (U) The Naval Submarine Academy has two laboratories equipped with computer-based training equipment. The Navy Simulation Submarine Attack Training Laboratory contains simulated periscopes, video cameras, and devices for depicting targets, target distances, angles, and position control. Submarine commanders may use the laboratory's equipment to simulate attacks on another submarine, a surface vessel, or a helicopter. The laboratory is also being used for research in submarine tactics and in the employment of torpedoes, missiles, and mines. The Submarine Tactical Simulator Manipulation Laboratory has a special submarine command classroom, which simulates Red and Blue forces. The classroom provides commanders with an all-position offensive and defensive training ground with arbitrary combat modes.

(6) (U) The Naval Combat Simulation Training Center is equipped with the Ocean Combat Simulation Training System. This system combines the use of computers, communications networks, image display, time control, quantity optimization, man and machine exchangeability, and artificial knowledge.

(7) (U) The Beijing Simulation Center, under the Ministry of Aerospace's Second Academy, was completed in 1993. The Chinese claim that it is the world's largest simulation center. The center's reported mission is assimilation of new imported technologies, avoidance of mistakes in real-time operations, and economical development of new technologies. The center consists at least 11 laboratories, including a radiofrequency-guidance simulation laboratory for homing missiles. It claims to possess the world's first combined millimeter-wave and microwave laboratory.

(8) (U) Foreign researchers are permitted to work at the center, as it actively pursues simulation-related business in communications, energy resources, chemical engineering, and other civil system engineering areas.

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(9) (S)

[redacted]

3. Tactical Engagement Simulations (U)

(S) By 1983 applied research into TES, or computer-based wargames, had begun.

[redacted]

a. **Methods (U).**

(1) (U) The most popular methods employed in TES within China are Lanchester equations, efficiency indices, and Monte Carlo techniques. Efficiency indices are used in most high-level models; lower-level models (probably division and below) employ Lanchester equations. Monte Carlo techniques are used at all levels of modeling. Expert systems are being developed for use in tactical training, as decision-making aids, and for weapons control. Other techniques employed in Chinese models and analyses include probability theory, linear programming, nonlinear programming, game theory, queuing theory, and regression analysis.

(2) (U) A surprising example of Chinese MOR in an area only recently developed in the West is nonlinear systems. A 1989 military textbook, Modern Scientific Methodologies and Their Military Applications, discussed dissipative structures, synergetics (or complexity), and catastrophe theory. Research in these areas is applicable to improving wargaming capabilities, cost and operational effectiveness analysis, and quantification of combat potential of forces.

(3) (U) No evidence of the employment of these methods in Chinese wargames or simulations has been identified to date; however, their inclusion in a military textbook indicates that Chinese knowledge and level of research in the area is near or at the state-of-the-art.

b. **TES Examples (U).**

(1) (C) China's early efforts at TES were typically organized in a modular structure and were intended for use by certain cadres. [redacted]

(2) (C) A simulation might take a week to set up and several hours to execute. These early TES were used to assist in the evaluation of new tactical concepts, for comparisons of battles, verification of military science concepts in division tactics, and training of commanders. [redacted]

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(3) (U) More recently developed TES continue to be modular in design, often building on previous work and models. However, these simulations are usually intended for combined-arms operations. The TES can now provide more detail on force structure, both friendly and enemy. Tactics for attack and defense, the relative strength of friend and enemy in terms of troop strength and firepower, operation of various service arms and branches, topographical and road conditions, weather, equipment performance, attrition of weapons and ammunition, number of killed and wounded in action, and logistics support capability are often incorporated into the system. Simulation capabilities include aid situation estimates, positions of friend and enemy, results of reconnaissance activities, military operations and feedback of results, quantitative analysis of the war situation, voice transmittal, and image displays. The system can also rapidly display the changing features of the operational environment (including air and ground) in an environment resembling a real war. Many of the simulations are executed in real time, often with enhanced audio-visual aids such as large-screen displays. The models are written in more advanced programming languages than their predecessors (e.g., Turbo C, Turbo Prolog, and Ada) and are beginning to utilize expert systems and artificial intelligence (AI).

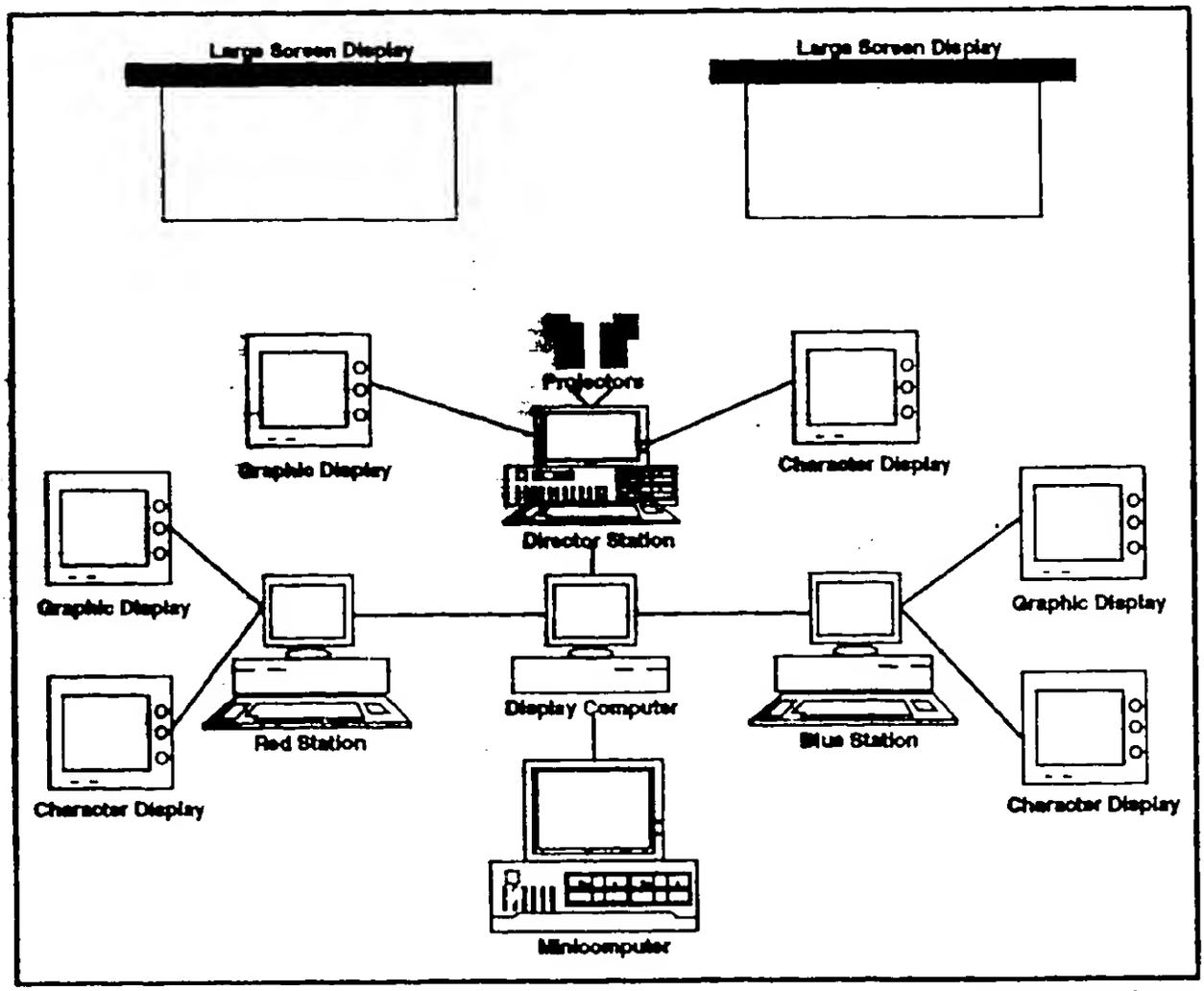

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Figure 3. (U) Typical System Configuration for Chinese TES.

4. Training Simulators (U)

a. Ground Forces (U).

(1) (U) Chinese ground forces began an aggressive program to develop advanced training simulators in 1984. The navy, air force, and Second Artillery quickly followed their lead with similar programs. These programs initiated the first phase (1984-87) of GSD's plan to develop training simulation systems and integrate them into all aspects of PLA training with a complete training system developed by 1993. Each service has rapidly moved ahead with simulators designed to cover all aspects of its individual combat responsibilities. In 1985, the Chinese conducted a tactical confrontation exercise involving ground and air units and employing a number of simulators. Similar exercises were conducted by the air force in 1986 and the navy in 1987. Between 1985 and 1987 simulator design advanced from tactical training to strategic training simulators, including a computerized campaign operations command simulation system for training in decision making.

Many of the training simulators are also used for parameter studies and system and operational analysis. The second phase of GSD's plan (1987-89) focused on integrating individual simulations into larger organic systems and consolidating simulator development throughout the services.

(2) (U) Figure 4 identifies the various types of simulators employed by the ground forces. The command-and-control simulators include campaign simulation systems that can simulate various tactical confrontations. Some simulations include aspects of logistics, data and information processing and display, as well as decision-making support for commanders and their staffs. The tactical simulations may include simulators for training in tactical communications, target tracking, or electromagnetic-pulse protection.

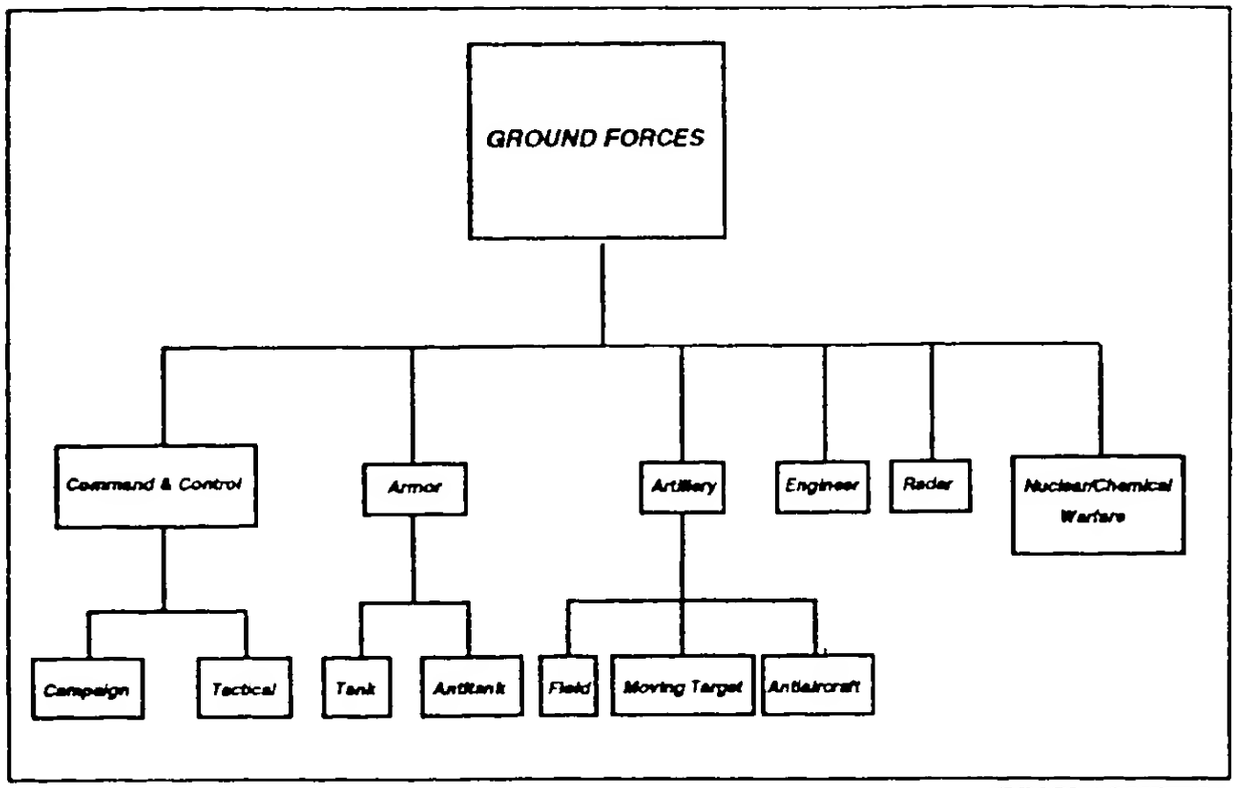

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Figure 4. (U) Ground Force Training Simulator Areas.

(3) (U) Training simulators for armor units include tank and antitank training simulators. More than 21 kinds of tank training simulators have been developed and are used to simulate tanks, electrically driven tanks, tank driving, tank electrical circuits, etc. The antitank simulators cover training for antitank missile and artillery gun firing, as well as simulating the effects of antitank mines on armor.

(4) (U) The artillery trainers include field and antiaircraft artillery (AAA). Artillery moving targets are also simulated for training in reconnaissance, combined-arms maneuvers, tactical exercises, and live-fire training. Field artillery trainers include gun simulators and meteorological forecasting in support of artillery. AAA simulators can simulate the AAA battlefield environment,

can assist training gun firing and communications, and can help with the integration of AAA with ground combat operations.

(5) (U) Other areas include engineer training simulators for driving, communications, and technical support; simulators developed for radar operation training; and simulated chemical and nuclear attacks. China claims to have been the first country to develop a chemical-defense training/operation system.

b. **Air Force (U).**

(1) (S) By the end of 1987 the air force had developed six major simulator systems, primarily for command-and-control training areas. In recent years, simulator development has increased rapidly. Development activities have been conducted chiefly for individual units or military institutions. [redacted]

(2) (U) Figure 5 identifies the principal areas of air force training simulators. The command-and-control simulators can simulate different battlefield conditions with various combat aspects, including flying formations, airfields, radars, AAA gun emplacements, and surface-to-air missile positions. Some of the simulations allow for variations in flight tactics, optimization of combat plans, and simulated battles.

(3) (U) Since 1989, the air force has had a complete series of flight simulators for all types of combat aircraft. Among the 16 flight simulators in the inventory are simulators for fighter interceptors, attack fighters, and long-range bombers. The flight simulators afford training in day-and-night spiral maneuvers, stunt flying, and flight and attack formations. Laser and electronic simulators are used for air-to-air and air-to-surface combat.

(4) (U) The Chinese have recently produced simulation systems for aerial combat between target drones, attack fighters, and air-to-air missiles and a three-dimensional (3-D) system with a digitally simulated cockpit, 6 degree-of-freedom platform, and 3-D vision. Despite these recent advances, Chinese flight simulators are assessed to be comparable to 1980s-vintage Western flight simulators.

(5) (U) The training simulators for air force bombing and missile firing include laser simulators for aerial targets and long-range firing. Some also simulate displays of firing and bombing effects, transmission of target-range information, targets, and landmark, radio, or integrated navigation.

(6) (U) The radar training simulators simulate different air situations and air exercises for operators. Others are used for navigation, electronic countermeasure, or flight-plotting training.

(7) (S) [redacted]

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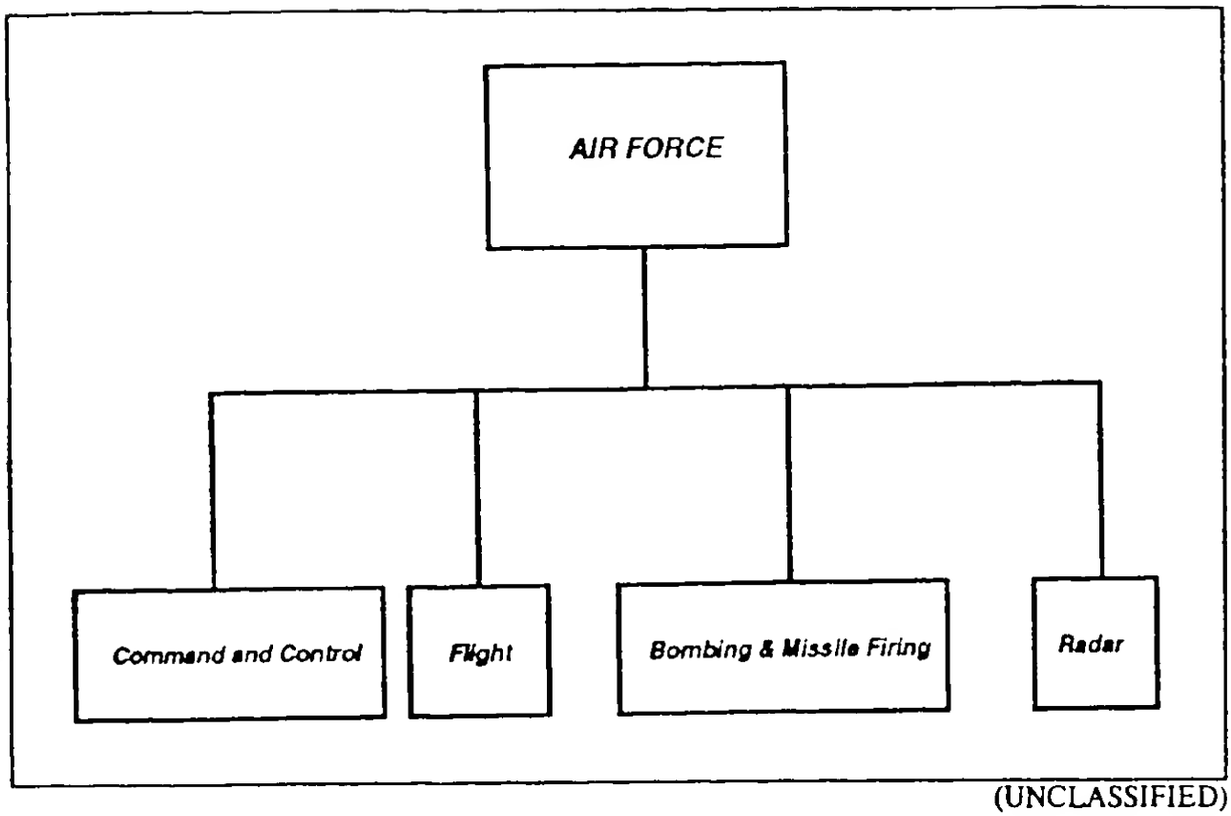

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Figure 5. (U) Air Force Training Simulator Areas.

c. (U) Navy (U). Figure 6 identifies the five categories for navy training simulators. The command-and-control systems cover various aspects of campaign operations including command and decision-level skills for tactical- and campaign-level operations. Training simulators for warship, torpedo, and missile attack may include one or more of the following features: analysis of target hits, summary of torpedo track, and simulation of missile targets. The radar and navigation training simulators simulate collision situations and/or other aspects of navigation for ship-steering training. Submarine training simulators cover sonar and radio operations, submarine tactics, submarine nuclear powerplant, torpedo assault, and navigation. Naval air force and AD simulators provide training in flight simulations and firing of AD missiles. Oth - simulators simulate diesel-engine technical problems and the acoustical ocean environment and underwater targets.

d. Second Artillery Corps (U).

(1) (U) The Second Artillery Corps has developed a variety of simulation systems for training launch battalions and guided-missile brigades (see fig 7). The corps also possesses a complete range of simulators for specialized training of personnel operating all types of PLA guided-missile systems.

(2) (U) The command-and-control training simulators of the Second Artillery Corps typically simulate the processes associated with a guided-missile test launch and related problems. Other training simulation systems provide training for guided-missile-unit launches, with emphasis on decision making, launch preparations, and guided-missile flight simulations. The guided-missile

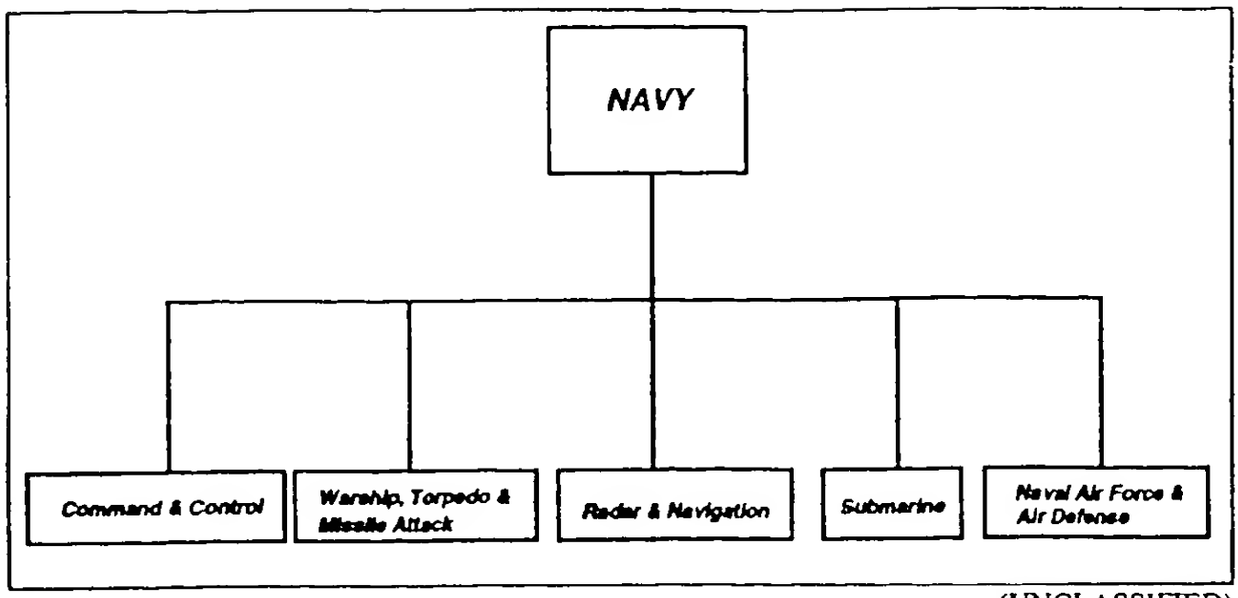

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Figure 6. (U) Navy Training Simulator Areas.

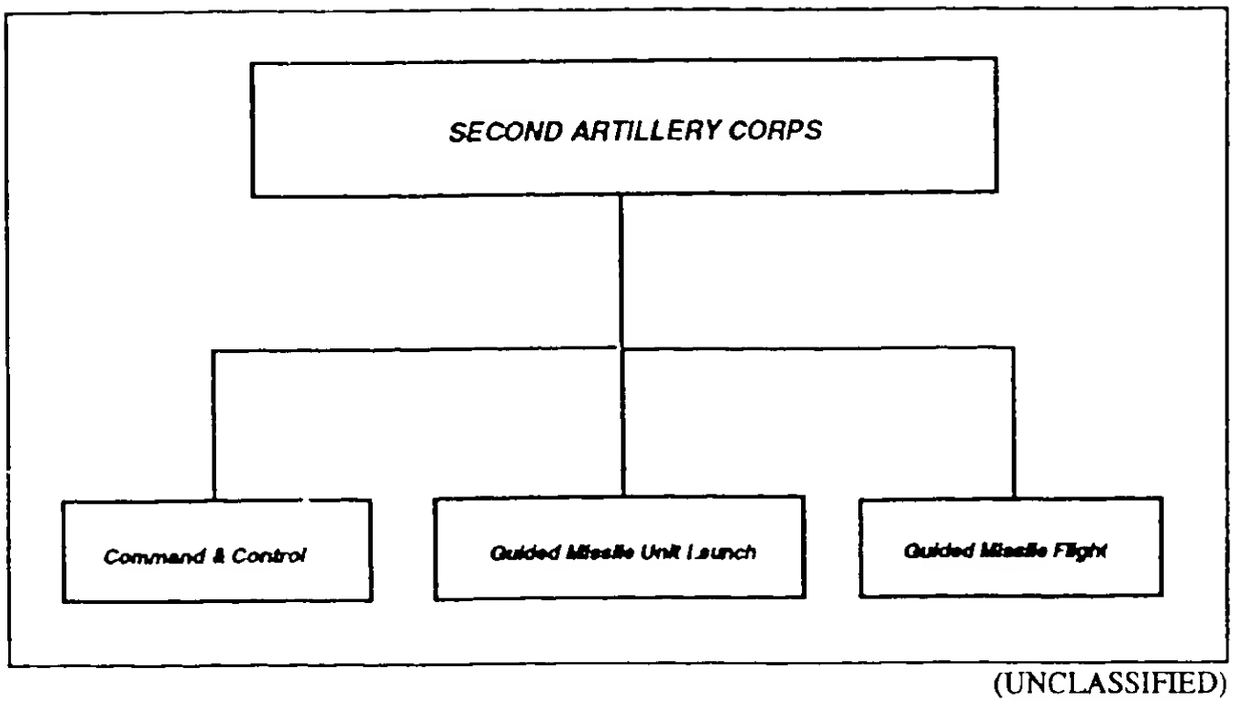

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Figure 7. (U) Second Artillery Training Simulator Areas.

flight simulations include simulations of the core operations of the missile and platform and real-time simulations of launches using 3-D graphics.

e. **(U) Management of Simulator Developments** (U). With over 30 000 training simulators of 450 varieties developed for use in unit training and at PLA institutes and colleges, the

Chinese are certainly enthusiastic about the development and use of training simulators. However, the lack of management for this enthusiasm has resulted in uncontrolled proliferation and duplication of simulators within the PLA. In order to maximize the benefits afforded by training simulators and to accomplish its goal of having a complete training system with a military-wide network linking operational training simulators, the PLA must implement a management structure that does the following:

- Promotes the initiative found within the MR and military units to continue developing simulators.
- Prevents duplication by tracking the development of new simulators and promoting their use throughout the PLA.
- Standardizes the use of simulators.

Earlier efforts by the GSD to do these things have failed, except for the Second Artillery Corps. Corps headquarters appears to have been somewhat successful in controlling the development of simulators and standardizing simulation systems.

5. Other MOR Applications (U)

a. (S/NF) [redacted]

b. (S/NF) Quantitative methods have also been used to analyze attacks, bombing, and aviation troop strength as an aid in decision making. [redacted]

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6. External Influences on Chinese MOR Developments (U)

(U) Although China's history in MOR dates back to the days of Sun Wu, many of China's developments in MOR can be attributed to influences from other countries, particularly the United States (US) and the former Soviet Union (FSU).

a. United States (U).

(1) (C/NF) [redacted]

[redacted]

(2) (U) Chinese scientists have studied the US Army Model Improvement Program's philosophy and noted the statement by two US researchers, J. D. Robinson and H. K. Fallin, that "model management and configuration control on an agency by agency basis leads to proliferation of incompatible models." As a result, the Chinese have tried to follow this philosophy in their model developments and have attempted to develop hierarchical models not only with a one-to-one correspondence with the military hierarchy but also with unique Chinese characteristics. One of BISE's roles in the OR communities is to apply this philosophy to Chinese model and simulation efforts. However, with the number of simulators, particularly training simulators, and the obvious duplications in efforts within and between the military services, BISE has had little success in controlling development.

(3) (C-NF) [redacted]

(4) (U) Based on the performance of high-technology weapons and reports on the use of various models and a computerized decision-making support system by the United States during the Gulf War, Chinese interest in US and Western simulator and model developments has increased significantly.

b. FSU (U).

(1) (U) The FSU has been another source of OR training and information, especially during China's early years in the field. Many Chinese researchers studied modeling and simulation at Soviet institutes during the 1950s and 1960s. Two books believed to have had a profound effect on Chinese MOR studies were written by Venttsel and Tsuyev, respectively, and translated into Chinese between 1974 and 1976.

(2) (U) A recent visit to the Beijing Simulation Center by the First Vice Chairman of the Ministerial Council of the FSU and a leading missile design engineer may result in a joint venture between China and the FSU. According to the Chinese press, the visitors were impressed by the center and stated that its missile manufacturing laboratory is 10 years ahead of that of the FSU and the surface-to-air laboratory is at least 5 years ahead of counterpart FSU facilities.

(3) (C-NF) Future Chinese efforts at acquiring FSU MOR technology are expected to focus on quick, cheap upgrades to current Chinese systems. [redacted]

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7. Future Chinese Efforts in MOR (U)

a. (U) Based on papers presented at the Second Beijing International Conference on System Simulation and Scientific Computing in October 1992, defense applications continue to be a primary focus of Chinese simulation research. Key among these are simulations involving aircraft, ship, missile, and radar systems. Chinese researchers are addressing many of the same topics as Western

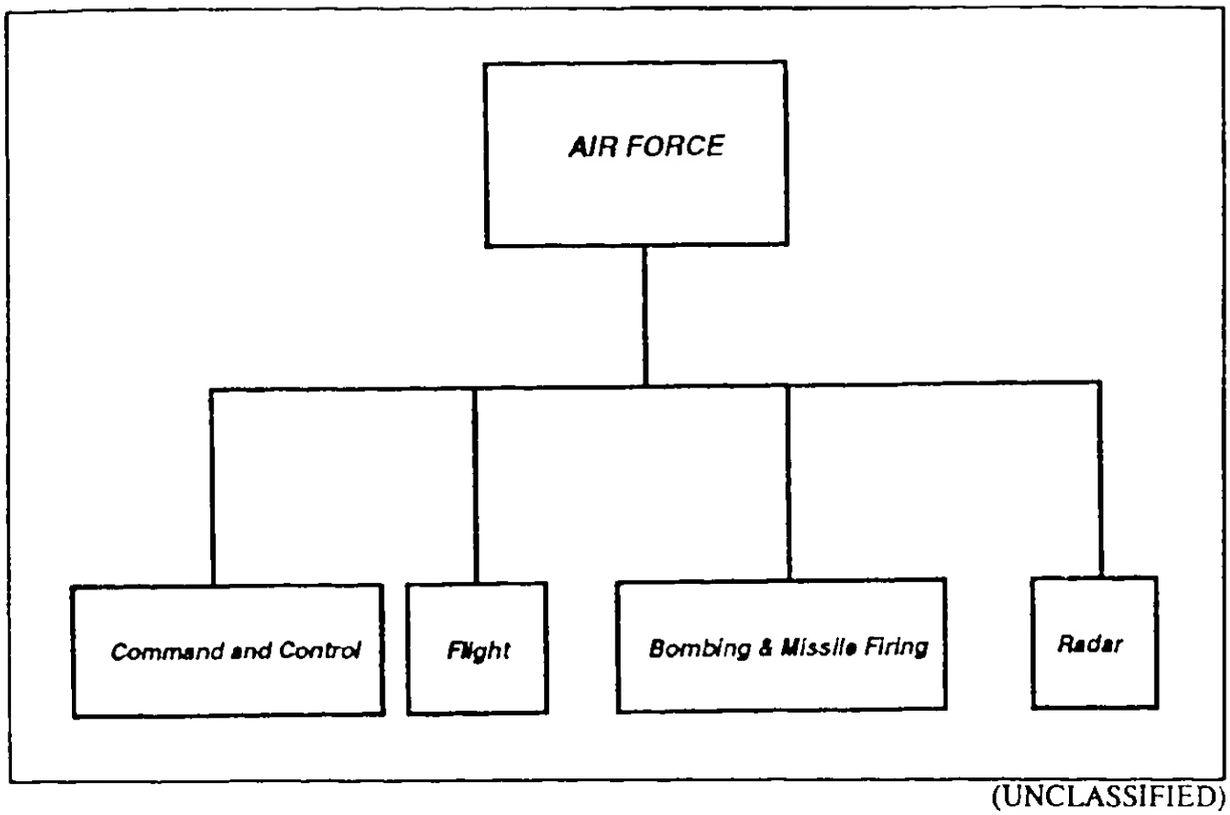

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Figure 5. (U) Air Force Training Simulator Areas.

c. (U) Navy (U). Figure 6 identifies the five categories for navy training simulators. The command-and-control systems cover various aspects of campaign operations including command and decision-level skills for tactical- and campaign-level operations. Training simulators for warship, torpedo, and missile attack may include one or more of the following features: analysis of target hits, summary of torpedo track, and simulation of missile targets. The radar and navigation training simulators simulate collision situations and/or other aspects of navigation for ship-steering training. Submarine training simulators cover sonar and radio operations, submarine tactics, submarine nuclear powerplant, torpedo assault, and navigation. Naval air force and AD simulators provide training in flight simulations and firing of AD missiles. Other simulators simulate diesel-engine technical problems and the acoustical ocean environment and underwater targets.

d. Second Artillery Corps (U).

(1) (U) The Second Artillery Corps has developed a variety of simulation systems for training launch battalions and guided-missile brigades (see fig 7). The corps also possesses a complete range of simulators for specialized training of personnel operating all types of PLA guided-missile systems.

(2) (U) The command-and-control training simulators of the Second Artillery Corps typically simulate the processes associated with a guided-missile test launch and related problems. Other training simulation systems provide training for guided-missile-unit launches, with emphasis on decision making, launch preparations, and guided-missile flight simulations. The guided-missile

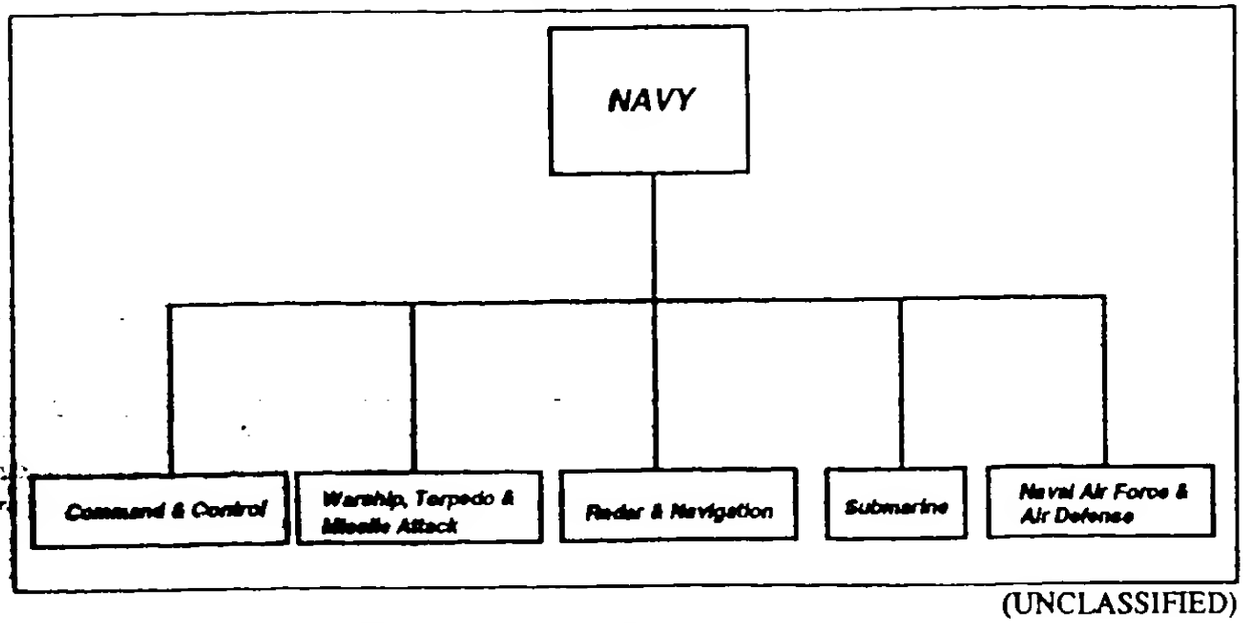

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Figure 6. (U) Navy Training Simulator Areas.

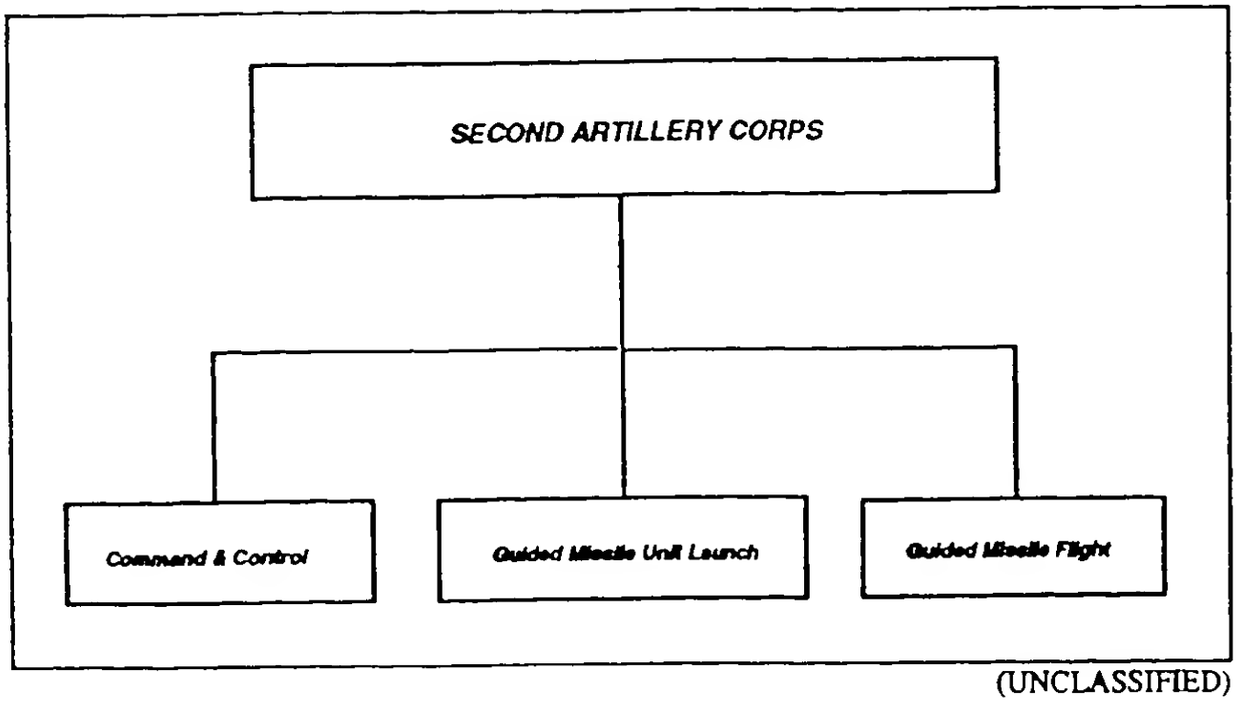

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Figure 7. (U) Second Artillery Training Simulator Areas.

flight simulations include simulations of the core operations of the missile and platform and real-time simulations of launches using 3-D graphics.

e. **(U) Management of Simulator Developments (U).** With over 30 000 training simulators of 450 varieties developed for use in unit training and at PLA institutes and colleges, the

Chinese are certainly enthusiastic about the development and use of training simulators. However, the lack of management for this enthusiasm has resulted in uncontrolled proliferation and duplication of simulators within the PLA. In order to maximize the benefits afforded by training simulators and to accomplish its goal of having a complete training system with a military-wide network linking operational training simulators, the PLA must implement a management structure that does the following:

- Promotes the initiative found within the MR and military units to continue developing simulators.
- Prevents duplication by tracking the development of new simulators and promoting their use throughout the PLA.
- Standardizes the use of simulators.

Earlier efforts by the GSD to do these things have failed, except for the Second Artillery Corps. Corps headquarters appears to have been somewhat successful in controlling the development of simulators and standardizing simulation systems.

5. Other MOR Applications (U)

a. (C) [redacted]

b. (C) Quantitative methods have also been used to analyze attacks, bombing, and aviation troop strength as an aid in decision making. [redacted]

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6. External Influences on Chinese MOR Developments (U)

(U) Although China's history in MOR dates back to the days of Sun Wu, many of China's developments in MOR can be attributed to influences from other countries, particularly the United States (US) and the former Soviet Union (FSU).

a. United States (U)

(1) (C/NF) [redacted]

[redacted]

(2) (U) Chinese scientists have studied the US Army Model Improvement Program's philosophy and noted the statement by two US researchers, J. D. Robinson and H. K. Fallin, that "model management and configuration control on an agency by agency basis leads to proliferation of incompatible models." As a result, the Chinese have tried to follow this philosophy in their model developments and have attempted to develop hierarchical models not only with a one-to-one correspondence with the military hierarchy but also with unique Chinese characteristics. One of BISE's roles in the OR communities is to apply this philosophy to Chinese model and simulation efforts. However, with the number of simulators, particularly training simulators, and the obvious duplications in efforts within and between the military services, BISE has had little success in controlling development.

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researchers: simulation software, languages and environment, manufacturing and training simulators, engineering analysis, hardware simulators (real-time and simulated time), uses of advanced techniques in simulation such as neural networks, AI, expert systems, parallel processing, and distributed simulation. However, in most cases Chinese developments have not yet reached the level of those in the West (often 10 to 20 years behind).

b. (U) The primary factor limiting China's growth in the area of MOR today and in the foreseeable future is a lack of computing power. Export restrictions imposed by the United States and other countries on the sale of advanced computers and design software to China have slowed developments in MOR. However, with the Chinese ability to copy and build foreign systems and their commitment to MOR applications, restrictions on the export of technology will not limit Chinese developments in MOR but will only extend their development time. MOR applications can be expected to closely follow developments in the West, and, if export restrictions are lifted, China can be expected to rapidly become a world leader in the area of MOR and simulations.

8. Summary (U)

a. (C) Chinese commitment to military science, particularly OR methods, is evidenced by the rapid advances made in modeling and simulation from the early 1980s to the present. Military and political leaders are using MOR methods to assist in policy making and determining the direction and growth of the PLA, which is certainly a dramatic change from pre-1980 times. TES have advanced from simple workstations to expert systems. [redacted]

b. (C) Training simulators are available not only for military training but also for use in aviation, space, chemical, and electrical power. Despite some GSD efforts to direct this growth in training simulators, it presently appears to be largely random and unfocused. [redacted]

c. (C) [redacted]

d. (C) [redacted]

e. (C) China's commitment to MOR and simulation efforts certainly indicates its intentions to be a leader in simulation and simulator technology. Actually, China now views itself as a world leader, behind the United States and the United Kingdom, in systems engineering research for military applications and training. Although specific details are lacking on most of the simulation systems developed by the Chinese, the available information indicates that current efforts are 5 to 10 years behind world standards in simulation technology. [redacted]

[redacted]

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LIST OF ACRONYMS (U)

3-D	three-dimensional
AAA	antiaircraft artillery
AD	air defense
AI	artificial intelligence
AMS	Academy of Military Science
BISE	Beijing Institute of Systems Engineering
CMC	Central Military Commission
COSTIND	National Defense Science, Technology and Industry Commission
FSU	former Soviet Union
FYP	Five-Year Plan
GSD	General Staff Department
MOR	military operations research
MORAI	Military Operations Research and Analysis Institute
MR	military region
NDU	National Defense University
OR	operations research
PLA	People's Liberation Army
R&D	research-and-development
TES	tactical engagement simulation

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